5702-01051

BELT AND SIDE IMPACT INFLATOR

TECHNICAL FIELD

The present invention relates generally to gas generator devices for inflatable restraint systems in automobiles, and relates more particularly to a belt and side impact inflator having a unique booster cup design and method of assembly.

BACKGROUND OF THE INVENTION

Inflatable restraint systems or "airbag" systems have become a standard feature in most new vehicles. These systems have made significant contributions to automobile safety; however, as with the addition of any standard feature, they increase the cost, manufacturing complexity and weight of most vehicles. Technological advances addressing these concerns are therefore welcomed by the industry. In particular, the gas generator or inflator used in many occupant restraint systems tends to be the heaviest, most complex component. Thus, simplifying the design and manufacturing of airbag inflators, while retaining optimal function, has long been a goal of automotive engineers.

Typical inflators are constructed having an elongate metallic body. Because many inflators utilize pyrotechnic gas generant compounds to produce inflation gas for the associated airbag, the inflator structure is necessarily robust, making such inflators correspondingly heavy. The long term success of driver-side and passenger side inflatable restraint systems has prompted automotive manufacturers to increasingly investigate and implement side impact inflatable restraints, as well as inflatable airbelts. Because the inflatable systems are typically mounted in the vehicle roof pillars, doors or seats, mounting space can be at a premium. Moreover, coupled with inherent difficulties in engineering inflators capable of producing the relatively small, punctuated inflation charges typical of side impact airbags and airbelts, such systems present a unique set of challenges to designers. Engineers have developed numerous designs for optimizing weight, operation and assembly; however, the pressure to downsize components and reduce manufacturing challenges continues to be acute.

Accompanying the need for ever simpler and more elegant designs is the desirability of inflators that are relatively robust yet capable of reliable operation even after storage periods of several years. One problem in particular associated with

long periods between installation in a vehicle and activation of the inflator relates to mechanical degradation of the gas generant or propellant material. Many gas generants are provided in a solid, typically tablet form. Jostling of the propellant within the inflator can have the undesirable effect of breaking or crumbling the propellant tablets, reducing their efficacy in some cases. Various spring-biased mechanisms for constraining movement of the propellant tablets have been proposed; however, these systems tend to increase manufacturing complexity and cost, and add extra components to the inflator, adding to the weight of the system.

SUMMARY OF THE INVENTION

In one aspect, the present invention provides an inflator for an inflatable restraint system in a vehicle. The inflator preferably includes an elongate substantially cylindrical inflator body having first and second ends and an inner peripheral wall. A booster cup is positioned within the inflator body and preferably extends substantially coaxially with the body, defining a combustion chamber therebetween.

In another aspect, the present invention provides an airbag module, preferably having an inflator with an elongate substantially cylindrical inflator body having first and second ends and an inner peripheral wall. A booster cup is positioned within the inflator body and preferably extends substantially coaxially with the body, defining a combustion chamber between the body and the cup.

In still another aspect, the present invention provides a vehicle occupant protection system, preferably having an inflator with an elongate substantially cylindrical inflator body with first and second ends and an inner peripheral wall. A booster cup is positioned within the inflator body and preferably extends substantially coaxially with the body, defining a combustion chamber between the body and the cup. The inflator is operable to provide an inflation gas to an inflatable restraint device such as an airbag or airbelt.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an elevational view of an airbelt inflator according to a preferred embodiment of the present invention;

Figure 2 is a sectioned side view of an airbelt inflator similar to the inflator of Figure 1;

Figure 3 is a partial schematic view of an airbag module and airbag;

Figure 4 is a partial view of a vehicle occupant protection system in a motor vehicle;

Figure 5 is a partial view of a vehicle occupant protection system in a motor vehicle.

Figure 6 is a sectional view taken along the line A-A of Figure 2.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to Figure 1, there is shown an elevational view of an airbelt inflator 10 according to a preferred constructed embodiment of the present invention. Inflator 10 is preferably a single stage device designed primarily for supplying and directing gas from the combustion of pyrotechnic gas generant materials into an inflatable vehicle safety airbelt, but is not limited to such an application. Exemplary, but not limiting airbelts and/or vehicle occupant protection systems are described in U.S. Patent Nos. 6,116,137, 6,170,863, 6,145,873, 6,142,512, and 6,523,856, herein incorporated by reference. Inflator 10 may be manufactured entirely from known materials and by known processes.

Turning to Figure 2, there is shown a sectioned side view of an inflator 10, similar to the inflator of Figure 1. Inflator 10 includes a substantially cylindrical inflator body 12, having a first end 11 and a second end 13. An initiator assembly 14 is positioned within first end 11, and is preferably secured therein by crimping inflator body 12 in a conventional manner. Initiator assembly 14 includes an initiator body 15 with an attached igniter or squib 16. It should be appreciated that some other attachment method such as mating threads or a snap-fit or press-fit connection could be used rather than a crimp to hold initiator assembly 14 in place. An O-ring 40, preferably a conventional elastomeric O-ring, preferably encircles initiator body 15, and fluidly seals first end 11 of inflator body 12. The igniter 16 has a set of electrical contacts 20, preferably accessible from first end 11. Igniter 16 may be any suitable known igniter, for instance, the igniter taught in U.S. Patent No. 5,934,705, herein incorporated by reference, and is preferably connected to an automobile electrical system whereby it can be activated in a conventional manner.

A unique booster cup 22 is positioned within inflator body 12, and is preferably press fit with initiator body 15, suspending cup 22 within inflator body 12. Booster cup 22 includes an end surface 29 that extends radially inwardly, or

substantially orthogonally to a longitudinal axis of the body 12, and is preferably substantially planar. A booster charge 18 is preferably positioned in booster cup 22, and is ignitable with igniter 16, activating inflator 10 in a conventional manner. In addition, an autoignition tablet 19 may be placed in booster cup 22 (or elsewhere in inflator 10), and can be ignited at an elevated temperature, in a manner well known in the art. A plurality of apertures 24 are preferably positioned around booster cup 22, and preferably spaced along the length thereof. Apertures 24 can fluidly connect the interior of cup 22, a first combustion chamber, with a second or main combustion chamber 26, within which the main gas generant charge 28 is positioned. Main chamber 26 is bounded at an outside by an inner peripheral wall 25 of inflator body 12, and on an inside by an outer peripheral wall 27 of cup 22. The main gas generant charge 28 may be any suitable propellant known in the art, and preferably consists of a non-azide propellant in tablet form. Exemplary, but not limiting compositions are described in U.S. Patent Nos. 5,035,757, 5,872,329, 5,756,929, and 5,386,775, herein incorporated by reference.

Various foils or similar materials may be placed over apertures 24 to seal the interior of cup 22 from main chamber 26, facilitating more robust burning of booster charge 18 in some instances, by allowing cup 22 to accommodate a resident interim gas pressure, in a manner known in the art. Sealing the contents of cup 22 from the outside environment also helps protect against degradation of the propellant. In a particularly preferred embodiment cup 22 extends approximately one half of a length of inflator body 12. Main propellant charge 28 preferably substantially fills chamber 26 and the tablets 28 are positioned in a geometrically ordered fashion inside chamber 26 such that they fill the space substantially uniformly. One preferred embodiment includes a plurality of substantially cylindrical tablets having their cylindrical axes (not shown) oriented substantially perpendicular to walls 25 and 27.

A cylindrical filter 38, preferably a metallic mesh filter, is positioned in inflator body 12, and filters particulate materials generated by the combustion of propellant charges 18 and 28. Filter 38 fills a volume of the housing 12 defined by the cross-section of filter 38 (shown in Figure 6) spanning from a point l_1 to a second point l_2. The longitudinal distance defined by the distance between l_1 and l_2 ranges from about one-fourth to one half of the total length of housing 12, or l_T. Adjustment of the length of the filter 38 therefore increases or reduces the pressure of the gas at the second end 13 and as such, may function as a filter, a gas pressure throttle, and/or

a heat sink depending on design criteria. Suitable, exemplary filters are available from Wayne Wire of Kalkaska, Michigan. Filter 38 also serves as a heat sink for hot combustion gases produced during inflator activation, cooling the gases before their ejection into the associated airbelt or airbag. In a preferred embodiment, a perforated disc 30, preferably an expanded metal, is positioned adjacent filter 38, and facilitates the creation of a resident interim gas pressure in inflator body 12 during combustion of the propellant. A nozzle 36 is preferably positioned adjacent disc 30 and secured with inflator body 12 by crimping second end 13, although the nozzle 36 might be threadedly attached to inflator body 12 if desired. An O-ring 39 is preferably circumferential about a portion of nozzle 36, and thereby creates a fluid-tight seal at second end 13. In a preferred embodiment, nozzle 36 includes a substantially cylindrical projection 37 that extends past second end 13. An internally projecting ledge 38 is preferably positioned within nozzle 36, and preferably includes a central aperture 40, that may be covered by a conventional burst shim (not shown).

In a preferred embodiment, inflator 10 is assembled by serially positioning the interior components in an innermost to outermost fashion, i.e. inserting those components adjacent first end 11 first, then placing the various additional components into the inflator body in order, and lastly sealing second end 13. A variety of different nozzles giving inflator 10 varying gas output characteristics can be utilized with inflator 10. For example, where it is desirable to provide a "thrusting" inflator, the nozzle 36 as pictured in Figure 2 might be utilized. Such a design results in a relatively narrow or smaller "plug" of a directed pulse of gas from inflator 10 during activation. Moreover, by restricting the diameter through which the gas is ejected from the inflator, a relatively greater thrust is imparted to the exiting gas per unit time. In contrast, where a thrust-neutral inflator is desirable, or where greater relative outward spreading of the gas discharging from inflator 10 is desired, a different nozzle can be used. For instance, a nozzle might be used having a greater number of apertures for discharging gas, or apertures that are spaced or otherwise designed to allow a more gradual exit of the gas, or more outward directing of the gas. Similarly, the extension 37 might be flared outwardly to assist in outwardly directing the discharging gas. Inflator 10 can be easily converted from a thrusting to a non-thrusting inflator by changing the nozzle used therewith.

Other advantages of the presently disclosed design result from the unique booster cup design. In a preferred embodiment, booster cup 22 is sized such

that it extends into inflator body 12, and abuts filter 38, thereby serving as a locator for filter 38, and providing a relatively snug packing arrangement for propellant tablets 28. Thus, cup 22, inflator body 12, filter 38 and initiator body 15 define chamber 26, and securely retain tablets 28 therein, preventing their being crushed by the igniter, filter, and other components during assembly and thereafter during storage of inflator 10. In addition, the booster cup design results in relatively consistent, repeatable bag performance. The relatively small, lightweight design makes manufacturing of the inflator easier and less expensive. Moreover, lighter weight is often desirable in vehicle inflatable restraint systems.

In the event of an impact, sudden vehicle deceleration, or other appropriate condition, an electrical signal is sent to igniter 16 from an onboard electronic controller (not shown) in a conventional manner. Igniter 16 subsequently ignites the gas generant booster tablets 18 located in cup 22. Ignition of booster tablets 18 creates a flame front that traverses apertures 24, resulting in a relatively rapid ignition of the main charge tablets 28 in cavity 26. Ignition of main charge 22 results in the very rapid creation of combustion gases in inflator body 12, and a consequent very rapid rise in the internal gas pressure in inflator body 12. When the internal gas pressure has risen to a sufficient level, it ruptures the burst shim, foil, etc. placed across aperture 40 (not shown). Thenceforth, the gas flows out nozzle 36 into the associated airbelt or airbag. In a preferred embodiment, inflator 10 is positioned in a vehicle B-pillar, and is operable to direct inflation gas into an inflatable safety restraint belt when activated by a vehicle sensing system. However, inflator 10 might also be positioned in a vehicle C-pillar, or even elsewhere in the vehicle. Furthermore, inflator 10, although especially useful in vehicle airbelts, may also be applicable in other vehicle occupant protection airbag systems. Finally, it is also believed that the present gas generator may be useful in other applications to include inflatable lifeboats and inflatable aircraft exit ramps, for example.

Turning to Figure 3, there is shown a schematic view of a portion of a vehicle occupant protection system 100. System 100 includes a module 160 that houses an inflator 110, for example an inflator similar to those described herein. A wide variety of inflator modules are known in the art. An exemplary, but not limiting module suitable for use in a side impact system in accordance with the present invention is known from United States Patent No. 6,398,294, hereby incorporated by reference. System 100 further includes an inflatable restraint device 170 that is stored

in a folded position within or proximate to module 160. Module 160 and its contents may be located, for example, in a vehicle seat, the side door of a vehicle, or elsewhere. Upon activation of the occupant protection system, inflator 110 is activated to discharge an inflation gas into airbag 170, inflating the same and protecting the vehicle occupant. Referring also to Figure 5, there is shown a similar occupant protection system 300 wherein a module 360, inflator 310 and airbag 370 are mounted in a vehicle side door 380. When it is desirable to activate the occupant protection system an appropriate signal is sent to inflator 310, which subsequently discharges inflation gas into airbag 370, for example via a throat 371. As airbag 370 inflates, it is preferably ejected from an interior of door 380 through a deployment opening 390. In a preferred embodiment airbag 370 displaces or bursts through trim on door 390, allowing airbag 370 to position itself between a vehicle occupant and the door and window of the vehicle.

Referring to Figure 4, there is shown another exemplary occupant protection system 200 wherein an inflatable airbelt 250 is utilized to assist in protecting the vehicle occupant in the event of a crash or sudden deceleration. In the embodiment pictured in Figure 4, an inflator 210, for example similar to the inflators described herein, supplies an inflation gas to airbelt 250 via a gas supply line 251. Inflator 210 may be mounted, for example, in the vehicle seat 252, or it may be mounted at various other locations in the vehicle.

The present description is intended for illustrative purposes only, and should not be construed to limit the breadth of the present invention in any way. Thus, those skilled in the art will appreciate that various modifications, additions, and alterations to the presently disclosed embodiments might be made without departing from the intended spirit and scope of the present invention. Other aspects, features and advantages of the present invention will be apparent upon an examination of the attached drawing Figures and appended claims.